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Curriculum design for empowered life-preparation and citizenship: A sociological analysis of the evolution of the Mathematical Literacy curricula

Author:
Marc P. North[1]

Affiliation:
[1]School of Education, Faculty of Social Science, University of Nottingham, Nottingham, United Kingdom

Corresponding author:
Marc North,
marc.north@nottingham.ac.uk

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The subject Mathematical Literacy (ML) prioritises an interplay of mathematics and real-life contexts in pursuit of an empowerment agenda for improved life opportunities. In seeking to identify processes of inclusion-exclusion afforded by different conceptualisations of this interplay, a network of Bernstein's theoretical constructs – classification, framing, discourses, and the pedagogic device – are used to analyse how different ML curricula conceptualise the notion of mathematical literacy and the criteria for legitimate communication, knowledge and practice in the subject. This analysis illustrates that despite differences in the formulation of the school subjects ML and Mathematics, enactments of the original ML National Curriculum Statement prioritised heavily mathematised methods in pseudo-realistic contexts. This approach thwarted the critical citizenship agenda of this curriculum and made it possible for ML to be criticised as watered-down mathematics. The analysis then reveals how the current ML Curriculum and Assessment Policy Statement, supported by specific curriculum features, has attempted to overcome these challenges by foregrounding a life-preparedness orientation for empowered self-management and citizenship. This involved weakening the classification of academic and everyday knowledge, strengthening the framing of curriculum specifications, and foregrounding criteria for legitimate communication, knowledge and practice around contextual problem-solving and decision-making. Challenges with this approach are considered.

Contribution: The article is relevant to those involved in curriculum, task and lesson design involving an interplay of mathematics and real-life contexts. The article aims to support the current curriculum review process in South Africa by decoding and theorising curriculum features and their impact for facilitating empowered life-preparation.

Keywords: mathematical literacy; curriculum design; sociology; Bernstein; pedagogic device; problem-solving; modelling; real-life contexts.

Introduction

Why and what mathematics?

Debates around the importance of mathematical learning and what mathematics secondary school learners should learn (e.g. Davis, 2001; Gravemeijer et al., 2017; Schoenfeld, 2004) are not new. The increasing quantitative and statistical demands of the workplace and world at large afford a degree of consensus of the importance of all learners being given access to mathematical learning experiences to prepare them for the future (Mason et al., 2015). However, persistently high failure rates in mathematics subjects, particularly at secondary school level, continue to prompt discussions of the type, structure and purpose of mathematics subjects and whether it is necessary for all learners to engage with the type of complex and abstract mathematical content that caters primarily for preparing learners to proceed to mathematically or scientifically oriented studies and professions. Some of these discussions foreground the notion of 'utility' by prioritising mathematical applications in real-life scenarios and argue the case for making mathematics more meaningful and relevant to learners, particularly those who find the higher levels of more complex and abstract mathematics difficult (Horváth et al., 2022).

In South Africa, these debates informed the institutionalisation of a distinction between the two secondary school subjects Mathematics and Mathematical Literacy (ML), both made available to different groups of learners in their final three years of schooling (ages 16–18). Mathematics is a traditional mathematics subject that supports the development of mathematical knowledge and competence with abstract mathematical structures through engagement with 'symbols and notations for describing numerical, geometric and graphical relationships' (Department of Basic Education [DBE], 2011b, p. 8). Although some problem-solving applications are expected in the subject, Mathematics is also viewed as a 'discipline in its own right and pursues the establishment of knowledge without necessarily requiring applications in real life' (Department of Education [DoE], 2003b, p. 9). By contrast, ML prioritises the use of more elementary mathematical contents in authentic real-world problem-solving experiences (DBE, 2011a, p. 8). This approach is in pursuit of an ideology for enabling a learner to become 'a self-managing person, a contributing worker and a participating citizen in a developing democracy' (DoE, 2003a, p. 10). In simplistic terms, the distinction is one of end goal: in Mathematics the end goal is competence with abstract mathematical contents and apprenticeship into mathematical ways of working; in ML the end goal is the capacity to use a combination of mathematical, contextual and technological knowledge, information and tools to solve problems and make informed decisions in situations encountered in daily life and workplace situations (DBE, 2011a, p. 8; DoE, 2003a, p. 10) – in other words, empowered preparation for life and citizenship. Thus, although both ML and Mathematics involve working with mathematical contents, in ML any mathematics used or learned is intended to be in service to and in support of problem-solving and decision-making in authentic real-world problem experiences. This positions ML as different in kind and purpose from Mathematics and, at curriculum level at least, ML is not subsumed within Mathematics (Graven & Venkatakrishnan, 2007). This has always presented the South African situation as a unique case for analysis, since in most international conceptions the development of mathematical literacy is seen as a component or by-product of the learning and application of mathematical knowledge rather than as a separate knowledge domain (e.g. De Lange, 2003; Kilpatrick, 2001; Organisation for Economic Co-operation and Development [OECD], 2018; Rafiepour Gatabi et al., 2012).

The subject ML is compulsory for and only available to learners not taking Mathematics, and originally targeted the 40% of the school-leaving population who historically opted out of continuing with Mathematics in their final three years of schooling (Clynick et al., 2004, p. 30). However, by November 2022, 62,5% (approximately 450 000 learners) of all Grade 12 learners sat the final ML matriculation examinations (DBE, 2023, p. 57). This means that on one level the introduction of this subject achieved a key objective by giving many more learners exposure to extended study involving applications of elementary mathematics and hope and promise for future workplace, study and career opportunities. On another level, though, these heightened enrolment figures have prompted concerns about decreasing enrolment in Mathematics, spurred by vastly different pass rates in the two subjects (85,7% for ML and 55% for Mathematics in 2022) (DBE, 2023, p. 56). The subject ML has also faced criticisms, with some commentators referring to the subject as a watered-down easier version of mathematics (Jansen, 2012; Nkosi, 2014), thereby thwarting the progressive agenda for empowerment that motivated the qualification.

One component of these criticisms is a judgement made about the lower level of mathematical demand of the ML curriculum content. A second component is a lack of clarity and agreement about whether and how the types of skills, knowledge and practices developed through ML are differently constituted and legitimised from the types of skills, knowledge and practices developed in Mathematics. After all, if both ML and Mathematics are evaluated according to competence with mathematical ways of working, then it is no wonder that the degree of complexity of the mathematical contents of the subject becomes a key measure of the value of the subject (Christiansen, 2007; Julie, 2006; Vithal & Bishop, 2006).

These challenges speak to the complexities of curriculum design for a school subject that engages both contextual and mathematical knowledge in pursuit of a progressive agenda for enhanced life-preparation and empowered citizenship. In 2010 a review of the original ML National Curriculum Statement (NCS) (DoE, 2003a) was initiated, resulting in the ML Curriculum and Assessment Policy statement (CAPS) curriculum (DBE, 2011a). For me, as the author of the CAPS ML curriculum, these concerns were at the foreground of attempts to more clearly define the criteria for legitimate knowledge and practice in the subject in this revised curriculum and to frame these criteria around practices needed for empowered life-preparedness rather than mathematical competence – thereby more clearly distinguishing ML from Mathematics. In doing this, a key aim was to reveal and challenge the processes of inclusion-exclusion (Skovsmose, 2012) afforded by different instantiations of the ML curriculum with a view to establishing a potentially more empowering educational experience.

Research contribution, focus and relevance

In respect of the above, this article offers a sociologically motivated theoretical analysis of the evolution of the ML curriculum to address the following questions:

- How is the school subject ML, and the criteria for legitimate knowledge, practice and communication in this subject, different from the school subject Mathematics?
- How and why are the criteria for legitimate mathematical literacy knowledge, practice and communication different in the ML NCS and in the ML CAPS?
- In what ways and how does the intended curriculum of the CAPS ML curriculum facilitate a life-preparedness orientation for empowered self-management and citizenship?

'Curriculum' here is taken to refer to the state-published and sanctioned message systems (Bernstein, 2005, p. 156) that outline what counts as valid knowledge, the specific vision of pedagogic practice for the transmission of the knowledge, and the criteria for evaluation of that knowledge, for the South African secondary school subject ML. The interpretative analysis adopted in this article operates primarily at the level of the 'intended' curriculum. The intended curriculum provides the description of the selected store of knowledge to be made available to learners and specification of the vision (underlying rationale, philosophy, ideology) and intentions of the learning process (Thijs & Van Den Akker, 2009). However, some insights will be offered about implications for enacted representations of this curriculum (e.g. in assessments and teacher practices). For ML, the intended curriculum is captured in a collection of text-based state-published documents (CAPS ML – DBE, 2011a; NCS ML – DoE, 2003a) that specify the vision and ideological underpinnings for the subject, roles and responsibilities for teachers and learners, the contents for teaching and learning, and in some instances specific assessment criteria.

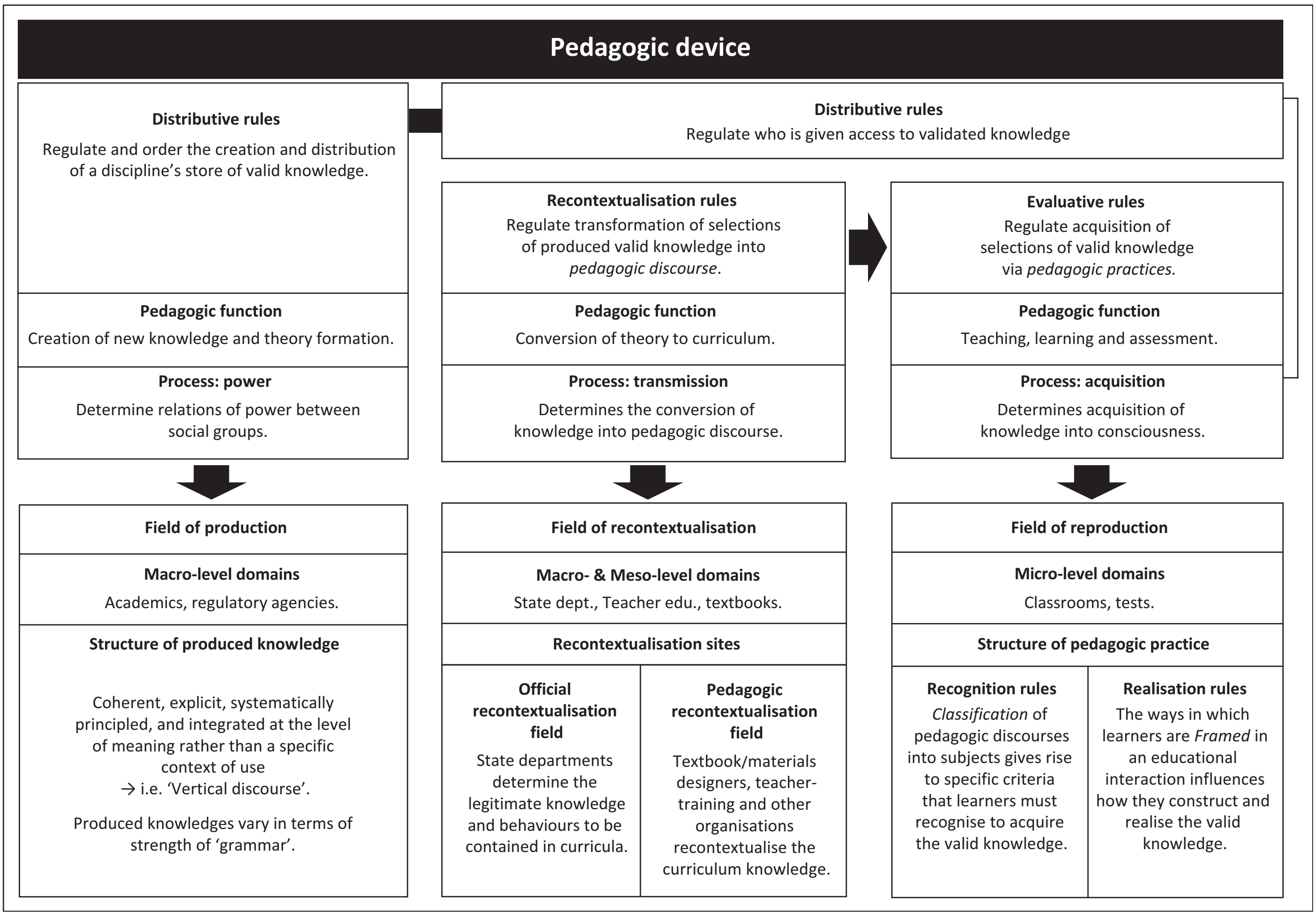
To address these research questions, a network of Bernstein's (1999, 2000, 2003) theoretical constructs is used as an analytic lens, including the pedagogic device, forms of discourse, classification and framing. These constructs facilitate analysis of how different forms of discourse and associated knowledges are conceptualised, organised, institutionalised, distributed, transmitted and evaluated, and the rules that define what counts as legitimate acquisition and realisations of that knowledge. By employing these constructs, the analysis will demonstrate ML and Mathematics as different pedagogic discourses. It will be argued that these discourses comprise different evaluation criteria that define the basis of legitimate knowledge, practice and communication for how selected mathematics and contextual elements are engaged within each subject. The analysis will also demonstrate how the ML curriculum itself has evolved. The original ML curriculum (instantiated in the NCS ML document; DoE, 2003a) was characterised by heavily mathematised ways of working primarily in relation to pseudo-realistic contexts. By contrast, the CAPS ML curriculum (DBE, 2011a) makes a deliberate attempt to reframe what it means to be mathematically literate around the types of skills needed for problem-solving and informed decision-making in genuine problem scenarios encountered in authentic real-life contexts – in other words, around an empowered life-preparedness orientation. This reframing is underpinned by a number of curriculum features that influenced the internal structure of the curriculum, the criteria for legitimate knowledge, practice and communication in the subject, and, hence, in how the subject is to be distinguished from other subjects like Mathematics. These curriculum features, their theoretical origins and underpinnings, and challenges with this approach, are discussed in detail.

This article makes a threefold contribution. First, the research is timeous given a post-Covid impetus for a further review of the ML curriculum by the DBE. As such, the arguments presented herein are intended to inform ongoing debates about the subject and to highlight the potential strengths and risks of different conceptualisations of mathematical literacy. Second, the uniqueness of the South African situation, the novel interplay of contextual and mathematical elements encapsulated in the CAPS ML curriculum, and the significant numbers of learners impacted by the intended empowerment agenda of this curriculum make this a continued worthwhile site for analysis. Third, the article adds to the discussions of those seeking to understand the complexities of integrating contextual and mathematical elements in curriculum design initiatives that influence school-based teaching and learning experiences in a meaningful and empowering way. Given this threefold impetus, the analysis in this article will be relevant to those both within South Africa and beyond involved in curriculum and resource design seeking to theorise, understand and mitigate the ways in which different contextual-mathematical interactions empower or restrict access to particular types of knowledge, learning and skills.

Theoretical framework

The pedagogic device

The pedagogic device describes the principles and processes through which knowledge (intellectual, practical, expressive, official or local) is transformed into pedagogic communication and distributed to different social groups via, for example, the education system (Bernstein, 2000, p. 50). The device also brings into focus the inherent relay of external relations of power and control that occur in this transformation process (Bernstein, 2003, p. 171). This transformation of knowledge is ordered by specific rules that regulate how and which knowledge is distributed to different groups (*distributive rules*), how knowledge is recontextualised into a pedagogic discourse that enables pedagogic communication about the knowledge (*recontextualisation rules*), and the criteria for how the knowledge is to be acquired (*evaluation rules*). These rules capture the relationship of power, knowledge and consciousness in the construction of pedagogic discourses and in how these discourses are made available to different groups (Bernstein, 2000, p. 56). Each of these rules is associated primarily, but not exclusively, with a specific field of activity – of *production* (macro-level), *recontextualisation* (meso-level) and *reproduction* (micro-level) (Singh, 2002). It is within these fields that selections of produced knowledge (e.g. produced by academics) are made available for recontextualisation into a form suitable for pedagogic communication (e.g. curriculum documents and textbooks) and distributed to other sites (e.g. schools) to be acquired (and internalised into consciousness) by designated groups (e.g. by specific learners) (Bernstein, 2003, pp. 181–184). Figure 1 summarises the fields and rules of the pedagogic device. Note that the arrows indicate hierarchical relations between the fields in the device: the distributive rules regulate which knowledge from the field of production is made available for recontextualisation into pedagogic communication and who this is made available to through recontextualisation and evaluation processes; this field in turn regulates the criteria through which the legitimised knowledge is to be recognised and realised as it is reproduced in pedagogic interactions (Bernstein, 2003, p. 172).



Source: Adapted from Smith, M.D. (2023). The neoliberal structures of English in Japanese higher education: Applying Bernstein's pedagogic device. *Current Issues in Language Planning, 24*(3), 334–356. https://doi.org/10.1080/14664208.2022.2102330

FIGURE 1: Overview of the fields and rules of the pedagogic device.

In relation to the analysis of school curricula that is the focus of this article, the pedagogic device enables a description of differences in the types of knowledge selected and recontextualised from varied fields of production in the development of the subjects ML and Mathematics in the official recontextualisation field. This facilitates analysis of similarities and differences in the forms of knowledge, practice and communication according to which participation in ML and Mathematics are legitimised and evaluated, and also shifts in the evaluation criteria between the NCS ML and CAPS ML curricula.

Distributive rules and the structure of produced knowledge

New knowledge is produced at a macro-level by national and global and other regulatory agencies and the academic community. Distributive rules distinguish which new knowledges are deemed more or less worthwhile and, in so doing, give rise to a field of production that constructs and validates a specialised discourse for specific knowledges with specialised rules of access and control over this discourse (Bernstein, 2000, p. 31). Agents in the field of recontextualisation (e.g. policymakers; curriculum developers) make selections from this store of produced and validated knowledge for recontextualisation into pedagogic discourses that facilitate the transmission and acquisition of the selected knowledge. Distributive rules again influence decisions about which forms of the recontextualised knowledge should be transmitted to which groups. Similarly, agents in the field of reproduction (e.g. school leaders; teachers) also employ distributive rules to determine who is given access to what knowledge in pedagogic interactions.

To understand the type of knowledge (in the field of production) that is subject to recontextualisation and transformation into pedagogic communication (in the field of recontextualisation) for distribution to different social groups (in the field of reproduction), it is necessary to first distinguish two different forms of discourse and the knowledge forms realised by each discourse. Here Bernstein (1999) distinguishes between *horizontal* and *vertical* discourses. A *horizontal discourse* refers to everyday or common-sense knowledge and entails strategies and tacit understandings that are linked closely to their context of use, are acquired through encounters in common problems via everyday interactions with peers, the home and society, and are designed to maximise encounters in those contexts (Bernstein, 1999, p. 159). The 'common' dimension of this type of knowledge means that everyone has potential access to it, which negates the need for this type of discourse to be transformed into a form suitable for pedagogic communication via a formal educational interaction. In addition, the outcome of a learning interaction involving a horizontal discourse is most commonly the acquisition of a competence (Bernstein, 1999, p. 161). Knowledges of horizontal discourses are segmentally organised, meaning that the realisation of a discourse or practice will vary depending on how a specific culture segments and specialises practices (Bernstein, 1999, p. 159).

By contrast, a *vertical discourse* is coherent, systematic and principled (as in the knowledge domains of mathematics or science), or comprises specialised languages with specialised criteria to be decoded or translated (as in the knowledge domain of history) (Bernstein, 1999, p. 159). The explicit and specialised knowledge structures realised by vertical discourses are related at the level of meanings rather than segments of context, which means that these explicit knowledges can be generalised across a range of contexts and applications (Bernstein, 1999, p. 161). Acquisition of the vertical discourse is realised by demonstrating competence with the specialised knowledges and languages that characterise the discourse, and is evaluated via a graded performance according to explicit evaluation criteria (Bernstein, 1999, pp. 161–162). It is this type of specialised knowledge that is subject to creation, ordering and distribution in the field of production of the pedagogic device. In addition, given the specialised nature of knowledge realised by vertical discourses, access is facilitated through recontextualisation and transformation of the knowledge into a form of pedagogic communication (in the field of recontextualisation) amenable to pedagogic interactions (in the field of reproduction). This means that, in contrast to everyday knowledge forms associated with horizontal discourses, not everyone has access to the specialist knowledges of vertical discourses; rather, different vertical discourses are differentially distributed to different groups and individuals through recontextualisation and pedagogic processes. In other words, the distributive rules of the pedagogic device regulate relations of power between different social groups (Bernstein, 2000, p. 28).

Within vertical academic discourses, distinctions can then be made between forms of knowledge exhibiting stronger and weaker '*grammars*'. Grammar here refers to the degree to which a form of knowledge is characterised by a language with an 'explicit conceptual syntax capable of "relatively" precise empirical descriptions and/or of generating formal modelling of empirical relations' (Bernstein, 1999, p. 164). The strength of grammar refers to the extent to which participation in and with a particular form of knowledge is dependent on an understanding of specialised language, symbols and discourse. For example, Mathematics requires engagement with a highly specialised, abstract and generalisable language (including symbols and notation), and mathematical language is easily identifiable. Thus, mathematics exhibits a strong grammar. By comparison, ML exhibits a weaker grammar due to the presence of more localised context-specific terms and notations that must be engaged with to support real-world problem-solving activities. This makes it harder to identify whether a specific utterance or term or symbol relates specifically to the discourse of the subject ML or whether it relates to a different discourse (e.g. the discourse of shopping). This issue will be discussed in more detail later.

Recontextualisation rules and the construction of pedagogic discourse

As mentioned above, agents operating in the field of recontextualisation select knowledge from the store of produced and validated knowledge and recontextualise and transform the knowledge into a form of specialised communication, namely *pedagogic discourse*. This pedagogic discourse is designed to facilitate the transmission and acquisition of the selected knowledge via an educational experience (Bernstein, 2003, p. 174). Importantly, recontextualisation involves the delocation of the original discourse from the field of knowledge production and its relocation to another site where it is changed: the recontextualised discourse no longer resembles the original discourse because it has been pedagogised in privileged texts (e.g. curriculum documents and textbooks) into a form of pedagogic communication suitable for transmission (e.g. by teachers) and acquisition (e.g. by learners) in the field of reproduction (Bernstein, 2000, p. 57). This recontextualised discourse exhibits specific *recontextualisation rules* that define which elements of the knowledge from the field of production are selected for inclusion in pedagogic interactions, how this knowledge is sequenced and paced in those interactions (or *framing* – see below), and how this knowledge is distinguished from other pedagogic discourses (or *classification* – see below), together with a specific theory of instruction that defines the rules of transmission of the discourse (Bernstein, 1999, p. 176). It is these recontextualisation rules employed in recontextualisation processes that distinguish specialist pedagogic discourses for different subjects. Recontextualisation can occur at two levels that produce the privileged texts for the discourse: at an *official level* (e.g. the state-sanctioned curriculum) and at a *pedagogic level* (e.g. textbooks, classroom support materials, and teacher training initiatives). Note that it is the *official recontextualisation* of notions of mathematical literacy, captured in a specific way in the ML curricula in South Africa, that is a key site of analysis in this article.

Evaluation rules and the classification and framing of pedagogic practices

The field of reproduction is the arena of teaching and learning, and of the rules for the evaluation of these. Here pedagogic discourse is transformed into pedagogic practice as the privileged texts created in the field of recontextualisation are reproduced (and transformed again) by teachers as they seek to generate shared understandings with learners

(Bernstein, 2000, p. 59). Two additional concepts, *classification* and *framing* (Bernstein, 2000), require unpacking here to facilitate discussion of the evaluation rules that regulate how and whether learners are able to acquire the pedagogic discourse. Within the education system, various boundaries are established to distinguish different subjects (e.g. Mathematics and ML), groups (e.g. higher and lower attaining sets), and institutional contexts (e.g. studios for art and laboratories for science). Bernstein (2000, p. 30) refers to the strength of the boundaries between categories as *classification* – in other words, how strongly classified or insulated different categories of discourses, groups and spaces are from each other. The stronger the classification, the stronger the boundary between categories, the more distinguishable the categories are from each other, and the stronger the degree of specialism of discourse, knowledge, practice and identity in each category (Bernstein, 2000, p. 31). In the establishment of boundaries, different classifications contain unique internal rules that need to be recognised in order to participate legitimately in those categories. These *recognition rules* define the special features that distinguish the contents of one classification from another (e.g. Mathematics from ML from History) and allow learners to make inferences about what meanings are considered relevant and legitimate in a specific discourse, thereby enabling them to realise acquisition of the discourse (Bernstein, 2000, pp. 41–42). Not being able to access the recognition rules leads to powerlessness because it becomes impossible to replicate the forms of communication, knowledge and practice appropriate to that classification. Thus, power is an inherent principle of the classification process (Bernstein, 2000, p. 29).

In addition to boundaries between classified categories, pedagogic experiences also involve issues of control within the interactions of those involved (e.g. teachers and learners). This is in relation to the *framing* of 'who' controls 'what' in respect of the message being communicated and also in terms of the form of communication: its sequencing, its pacing, the criteria that regulate how the communication is to be successfully realised, and the origins of the message content (Bernstein, 2000, pp. 29; 36–37). In a student-teacher interaction in a school setting, strong framing gives the teacher heightened control over what and how knowledge is communicated, sequenced and paced, which means there is a clearly visible pedagogic practice. By contrast, weak framing gives learners more opportunity to influence and direct the learning process, thereby making the pedagogic practice less visible (Bernstein, 2000, p. 38). Where classification constitutes specialised recognition rules for each classification, framing regulates the means through which learners acquire the discourse in a classification (Bernstein, 2000, p. 37). A key role of the teacher, then, is to support learners to recognise the principles and procedures of legitimate communication in the discourse. This will give them access to the rules, the *realisation rules*, that will enable them to realise acquisition of the discourse (Bernstein, 2000, p. 42). The combination of recognition and realisation rules enables both learners and teachers to evaluate what counts as legitimate realisations of the curriculum: teachers use these *evaluative rules* in their pedagogic practices to evaluate student understanding, while learners draw on the evaluative rules to acquire understanding.

In combination, the principles of classification and framing provide the rules of pedagogic practice for a specific pedagogic discourse: in specific relation to the institution of schooling, the strength of classification defines the structure and variations between curricula and subjects, while framing defines the structure and variations in pedagogy (Bernstein, 1971). As such, changes (from strong to weak) in the classification and framing of pedagogic discourses (within the field of recontextualisation) will affect how pedagogic practice is organised (in the field of reproduction), including the types of communication, knowledge and practices considered valid, the criteria needed to recognise and realise the discourse, the type of instruction foregrounded, the roles of the teacher and student, the nature of knowledge itself, and the type of understanding (consciousness) that is privileged and expected (Bernstein, 2000, p. 39).

This, then, brings to an end the discussion of the rules and fields of the pedagogic device. In the next section, the device is used to theorise ML and Mathematics as distinct pedagogic discourses. It will be argued that although both subjects recontextualise contents from the vertical discourse of the field of knowledge production of the discipline of mathematics, there are additional recontextualisation rules (including how ML and Mathematics are conceptualised within the field of knowledge production of mathematics education) that classify the subjects with unique and different recognition and realisation rules. In addition, the device is also used to identify shifts in the structuring of knowledge and evaluation in the NCS ML and CAPS ML curricula. Figure 2 captures this intended application of the pedagogic device in relation to the three areas of focus framed by the research questions.

Mathematics and Mathematical Literacy as distinct pedagogic discourses

This section addresses the first research question: *How is the school subject ML, and the criteria for legitimate knowledge, practice and communication in this subject, different from the school subject Mathematics?*

As identified previously, the school subjects Mathematics and ML are characterised as different in kind and purpose. Viewed through the lens of Bernstein's pedagogic device, these two subjects represent *distinct classifications of pedagogic discourses* in the *field of recontextualisation*. Both pedagogic discourses draw on selections of mathematical knowledge recontextualised from the *vertical discourse* of the discipline of mathematics in the *field of production*. Both discourses also foreground engagement with selections of extra-

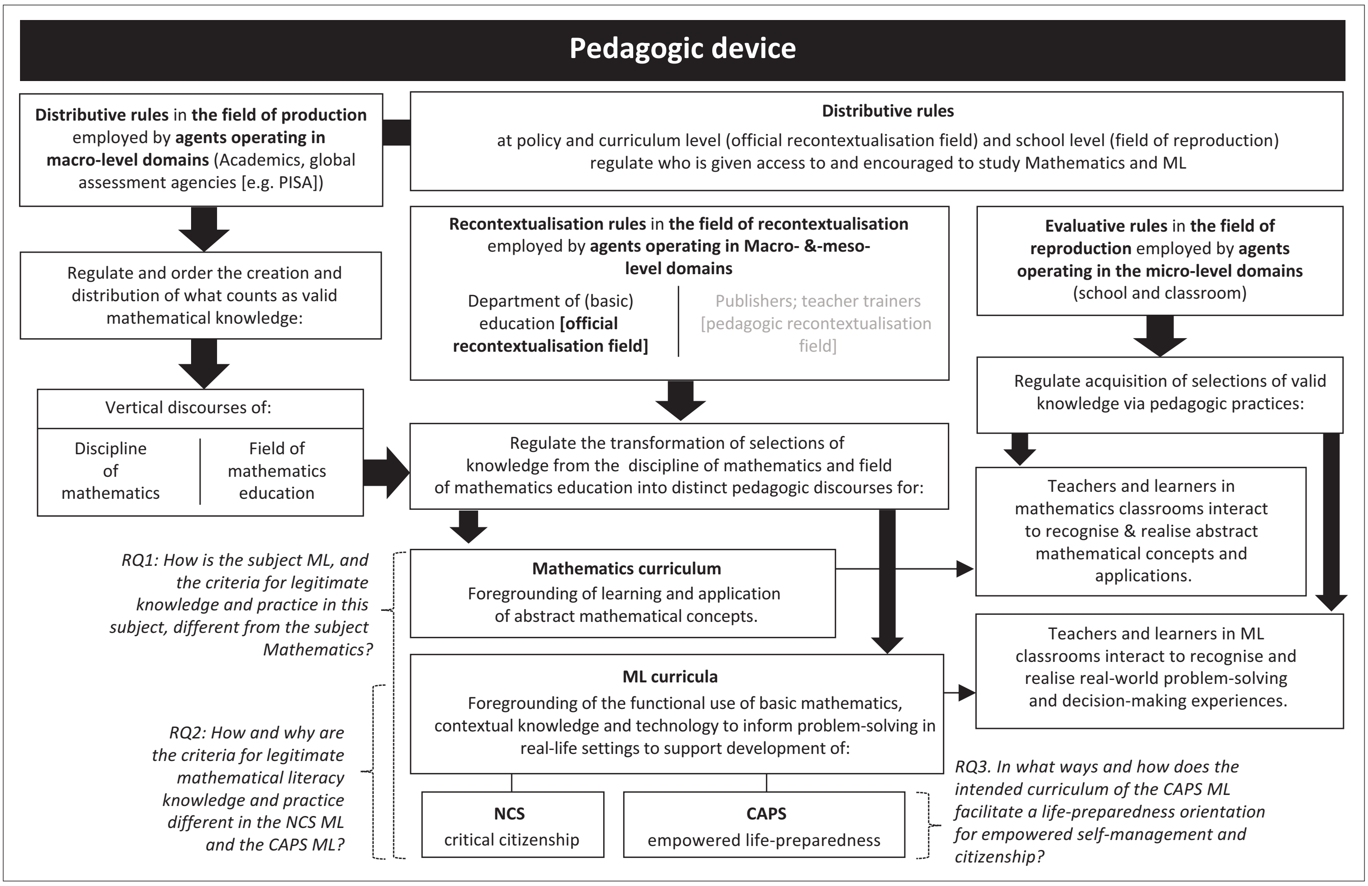


FIGURE 2: Analytical framework of the use of Bernstein's (1999, 2000, 2003) theoretical constructs in the analysis of the ML and Mathematics curricula.

mathematical contextual elements located outside the discourse of mathematics (e.g real-world applications). These selections have been structured into a systematic, coherent and principled form for each subject, and captured in distinct curriculum and assessment policies in the *official recontextualising field* by the DoE and DBE (Mathematics – e.g. DBE, 2011b; DoE, 2003b; ML – e.g. DBE, 2011a; DoE, 2003a). The pedagogic discourses of the subjects Mathematics and ML have then been made available to different groups via specific *distributive rules* that define the criteria for access to each classification. Namely, at a policy level (the *official recontextualising field*) ML was intended for the high proportion of learners who historically may have opted out of continuing with Mathematics in their final three years of schooling while Mathematics is targeted at learners intending to pursue future mathematics-related areas of study and work. At school level (the *field of reproduction*), ML is commonly selected by learners who do not require mathematics for future study or work opportunities, learners who have had unsuccessful prior learning experiences in Mathematics, and learners who see ML as easier than Mathematics (Jacobs & Mhakure, 2015; Masuku, 2014).

Although both subjects draw on selections of mathematical knowledge and extra-mathematical content, there are a number of key differences in how these selections are recontextualised (i.e. the *recontextualisation rules*) into pedagogic discourses for each subject. First, the scope, quantity and complexity of the mathematical content in ML is significantly lower than in Mathematics. This applies to both the NCS ML and CAPS ML curricula, with the former specifying 'basic mathematical skills' (DoE, 2003a, p. 9) and the latter 'elementary mathematical concepts' (DBE, 2011a, p. 8) needed for analysing and solving problems encountered in everyday situations. Most of the mathematics content in ML reflect content already encountered in previous grades, with the main focus instead on their functional use in real-world problem-solving experiences. It is for this reason that the original NCS ML curriculum states that 'Mathematical Literacy should not be taken by those learners who intend to study disciplines which are mathematically based, such as the natural sciences or engineering' (DoE, 2003a, p. 11). By contrast, the content of the subject Mathematics builds on and extends the mathematics encountered in previous grades to provides the platform for learners seeking future study or career opportunities involving theories and applications of abstract mathematical relationships (DBE, 2011b, p. 10; DoE, 2003b, p. 11).

A second difference shifts focus away from how knowledge in each subject is recontextualised from selections of the discipline of mathematics. Instead, we can also consider the distinctive way in which learning is conceived in the pedagogic discourses for each subject, which directly affects the *evaluation rules* for the acquisition of each discourse. As stated previously, Mathematics is viewed by the DBE as a symbolic language for describing numerical, geometric and graphical relationships (DBE, 2011b, p. 8). Although the 'applied' dimensions of problem-solving and modelling are recognised (DBE, 2011b, p. 8), the subject is also seen as a discipline in its own right that does not necessarily require real-life applications (DoE, 2003b, p. 9). Acquisition of the pedagogic discourse of Mathematics is to be *recognised* and *realised* by communicating understanding of its specialised intra-mathematical content and by using these specialised components to identify, describe, model, solve and engage critically with mathematical and, at times, extra-mathematical problems involving mathematical patterns and relationships (DBE, 2011b, pp. 8–9). In other words, the evaluation criteria reside in the principles of the *vertical discourse* of mathematics, even when extra-mathematical elements are included. This conceptualisation of the pedagogic discourse of the subject Mathematics shares similarities with particular perspectives (in the *field of production of mathematics education*) regarding the nature of mathematics as: an abstract science of developing, describing and understanding intra-mathematical relationships, patterns, objects, symbols, notation and language (pure mathematics), and applied to support understanding and develop aspects of extra-mathematical content (applied mathematics), and also as a teaching subject that facilitates transmission, the dissemination and the furtherance of mathematics as a discipline (Niss, 1994, p. 367).

By contrast, the subject ML foregrounds an intention for enabling learners to 'develop the ability and confidence to think numerically and spatially in order to interpret and critically analyse everyday situations and to solve problems' (DoE, 2003a, p. 9). This is to be achieved by engaging in real-world problem-solving experiences in authentic real-life contexts in pursuit of critical citizenship (NCS ML) and empowered life-preparedness (CAPS ML): 'The approach that needs to be adopted in developing Mathematical Literacy is to engage with contexts rather than applying Mathematics already learned to the context' (DoE, 2003a, p. 42); 'mathematical content is simply one of many tools that learners must draw on in order to explore and make sense of appropriate contexts' (DBE, 2011a, p. 9). Acquisition of the pedagogic discourse of ML, then, is to be *recognised* and *realised* by demonstrating confidence and skill in using a combination of mathematical, contextual and technological tools, understandings and knowledge to make sense of, solve and communicate informed decisions about problems encountered in both familiar and less or unfamiliar daily life, workplace and societal contexts: 'Learners who are mathematically literate should have the capacity and confidence to interpret any real-life context that they encounter, and be able to identify and perform the techniques, calculations and/or other considerations needed to make sense of the context' (DBE, 2011a, p. 8). As such, and in contrast to the subject Mathematics, any mathematical content used or learned in the subject ML has a functional purpose for supporting informed and critical decision-making and problem-solving in real-world contexts.

This conceptualisation of the pedagogic discourse of the subject ML shares similarities with particular perspectives (in the *field of production of mathematics education*) regarding the nature of mathematical literacy. To begin with, conceptualisations of mathematical literacy in this field share emphasis on an interplay of mathematics and real-life contexts: the functional use of mathematics in real-life (extra-mathematical) settings and problems (Niss, 2015, p. 410). Differences between conceptualisations arise specifically with respect to the perceived outcome and purpose of integrating mathematics and context: 'Different conceptions of mathematical literacy are related to how the relationship between mathematics, the surrounding culture, and the curriculum is conceived' (Jablonka, 2003, p. 80). In relation to these differences, Julie (2006, p. 62) argues that the definitions of mathematical literacy are on a continuum, spanning from mathematical literacy for entry into mathematics (1) to mathematical literacy for critical interaction with mathematical structures and installations in society (4). Jablonka (2003, p. 76) illuminates the in-between categories as: (2) developing basic computation skills needed for everyday contexts and (3) developing more complex problem-solving and modelling skills needed for society and the workplace (Jablonka, 2003). These perspectives represent a 'spectrum of agendas' for mathematical literacy, and the shift from (1) to (4) represents a change in prioritisation of the mathematical terrain to the contextual terrain (North, 2015, p. 38). While the first perspective has as an explicit goal the development of mathematical knowledge, the fourth perspective aims to develop critical engagement with real-world problem environments and the forms of communication, knowledge and practice that facilitate empowered participation, communication and decision-making in those environments. In respect of these different conceptions, the descriptions given above of characteristics of the pedagogic discourse for the subject ML signal a combination of agendas. Specifically: in the NCS ML curriculum – computation skills for everyday self-management (2) and critical engagement with how mathematics is used in the world (4); in the CAPS ML curriculum – preparation for problem-solving experiences in life and the workplace (3). The specifics of how these agendas are characterised in each of the ML curricula will be discussed further in the next section.

The heightened emphasis in the subject ML on more contextually oriented agendas signals another distinctive recontextualisation rule for the pedagogic discourse of ML. Namely, that the pedagogic discourse for this subject includes selections of knowledge recontextualised from both *vertical* and *horizontal discourse* domains. As discussed above, selected mathematical content is recontextualised from the vertical discourse of the discipline of mathematics in the field of production. However, and in addition, horizontal discourse elements – including everyday situations, problems, language, notation, knowledge, tools and techniques – are also appropriated and recontextualised from the terrain of the real world. In other words, the pedagogic discourse for ML recognises that effective problem-solving in real-world settings requires two different types of knowledge: competence with selected specialised mathematical content generalisable across a range of contexts and applications, and understanding of local and context-specific information, language, practices and considerations that reflect how people act, make decisions and communicate effectively in those contexts. Hence the stipulations in the NCS ML and CAPS ML curricula for the subject to be 'rooted in the lives of the learners' (DoE, 2003a, p. 42), with 'incorporation of local practices' (DoE, 2003a, p. 43), and recognition of 'non-mathematical skills and considerations in making sense of those contexts' (DBE, 2011a, p. 8). Whereas in the subject Mathematics the *recognition* and *realisation rules* reside primarily in the vertical domain discourse of mathematics, in the subject ML these rules require consideration of both mathematical and everyday forms of knowledge, practice and communication. Faculty only with horizontal discourse elements of the everyday world is not sufficient. After all, if the content of an everyday practice can be learned in the context of the practice, why is there a need to engage such content in a formal academic experience? Equally, faculty only with vertical discourse elements of the mathematical domain is also insufficient since competence in intra-mathematical contents does not necessarily equate to enhanced functionality in the extra-mathematical real-world. The implication of the above is that, at the level of curriculum intention at least, the discursive practices of ML have *weaker grammars* than Mathematics, involving some discursive elements and practices that are linked to their context of use and which may not have a specialised or explicit conceptual syntax or be generalisable to other contexts.

Despite these differences in the recontextualisation rules and consequent pedagogic discourses for the subjects ML and Mathematics, a number of curriculum features of the original NCS ML curriculum, together with operationalisations of this curriculum in national assessments, blurred the distinctions in the *evaluation criteria* of these subjects. This resulted in participation in ML being evaluated primarily accordingly to overly mathematised ways of working in pseudo-real contexts. The system-wide curriculum review in 2010 that resulted in the CAPS ML curriculum provided the opportunity to more clearly distinguish ML from Mathematics and to more clearly define the *recognition* and *realisation rules* around contextual problem-solving and informed decision-making practices. In the next section, the evolution of these two ML curriculum instantiations is discussed, and a range of Bernstein's concepts are used to rationalise differences between the curricula.

Evolution of the intended curriculum for Mathematical Literacy in South Africa

The discussion in this next section will address the second research question: *How and why are the criteria for legitimate mathematical literacy knowledge, practice and communication different in the ML NCS and in the ML CAPS?*

First curriculum instantiation – Mathematical Literacy National Curriculum Statement

The original curriculum for the subject ML, encapsulated within the NCS framework, embodied a *theory of instruction* of an outcomes-based curriculum model that prioritised a learner-centred and activity-based approach to education (DoE, 2003a, p. 2). This curriculum was structured around four broad learning outcomes for learners to demonstrate by the end of the learning process – LO 1: Numbers and operations in context; LO 2: Functional relationships; LO 3: Shape, Space and Measurement; LO 4: Data Handling (DoE, 2003a, pp. 11–12). Each learning outcome was accompanied by a number of assessment criteria stipulating content, skills and procedures to evidence each learning outcome (Figure 3).

Within this outcomes-based approach, teachers were positioned as active mediators of learning, interpreters and designers of learning programmes and materials (DoE, 2003a, p. 5). This characterised *weak framing* on two dimensions. First, with respect to the degree of state control of the selection, sequencing and pacing of content. Second, with respect to both teachers and learners being given heightened control and responsibility as co-participants in the learning process. Understandably, this approach sought to directly redress the discriminatory, exclusionary and highly controlled nature of the Apartheid education system. Consequently, the curriculum aims also directly foregrounded a critical citizenship dimension, with emphasis on the importance of education (and participants in the education system) for building an equitable democratic society (DoE, 2003a, pp. 1, 5, 10). To facilitate this critical citizenship dimension, the NCS ML curriculum foregrounded engagement with real-life contexts 'rooted in the lives of the learners' (DoE, 2003a, p. 42), signalling weakened *classification* of the boundary strength between academic and everyday

Learning outcome 2	Assessment standards
Functional relationships	We know this when the learner is able to:
The learner is able to recognise, interpret, describe and represent various functional relationships to solve problems in real and simulated contexts.	10.2.1 Work with numerical data and formulae in a variety of real-life situations, in order to establish relationships between variables by: • Finding the dependent variable; • Finding the independent variable; • Describing the rate of change. (Types of relationships to be dealt with include linear, inverse proportion and compound growth in simple situations.)

Source: Department of Education (DoE). (2003a). *National curriculum statement grades 10–12 (General): Mathematical literacy* (p. 20). Pretoria: Government Printers

FIGURE 3: Learning Outcome and Assessment Standard structure in the NCS ML curriculum.

knowledge. At an ideological level, then, the NCS conception of mathematical literacy foregrounded learners being able to use mathematics to engage critically with societal issues (intended *realisation rules* for legitimate acquisition of this discourse) (DoE, 2003a, p. 10).

However, the four learning outcomes that frame the NCS ML curriculum content corresponded closely to traditional mathematics content domains and resemble the learning outcome domains of the Mathematics curriculum (LO 1: Numbers and Number relationships; LO 2: Functions and Algebra; LO 3: Shape, Space and Measurement; LO 4: Data Handling and Probability) (DoE, 2003b, pp. 12–14). In addition, these content domains were strongly *classified* (internally) from each other, with no clear commentary or cross-referencing of how the content of one learning outcome might relate to another. Progression through the curriculum was structured predominantly around engagement with increasingly sophisticated mathematical content. For example, 'Solve problems in 2-dimensional and 3-dimensional contexts by estimating, measuring and calculating values which involve: Grade 10 – volumes of right prisms; Grade 11 – volumes and surface areas of right prisms and right circular cylinders; Grade 12 – volumes and surface areas of right prisms, right circular cylinders, cones and spheres' (DoE, 2003a, pp. 24–25). This weakened the strength of external *classification* between ML and Mathematics, since both were organised around increasingly complex mathematical content. This made it harder to distinguish ML and Mathematics as different subjects, characterised by different pedagogic discourses, and comprising different forms of knowledge, practice and communication and different *recognition* and *realisation rules* for acquisition of these. The consequence was enactments of the NCS ML curriculum in national assessments (*official recontextualising field*) and pedagogic resources such as textbooks (*pedagogic recontextualising field*) that dealt with the interplay of mathematics and context in vastly different ways – in other words, divergent perspectives on the *recognition and realisation rules* for the subject. The national examinations were a particular case in point here, foregrounding heavily mathematised ways of working, commonly in relation to overly simplified pseudo-real-life contexts bearing limited resemblance to authentic real-life practices (North, 2015, 2017). Confidence and competence with, primarily, specialised mathematical *grammars*, procedures, forms of knowledge and ways of working, and the ability to recognise (*recognition rules*) and communicate about mathematical elements in contrived contextualised problems (*realisation rules*), were taken as evidence of successful acquisition of the pedagogic discourse of ML.

The prevalence and privileging of heavily mathematised forms of practice foregrounded an agenda for basic computation skills needed for everyday contexts (agenda 2). This agenda was at the expense of more complex real-world problem-solving and modelling (agenda 3) and critical evaluation skills needed to facilitate critical engagement with complex real-world problems (agenda 4) (Jablonka, 2003; North, 2015). As such, this agenda contradicted and thwarted both the curriculum intention for weakened *classification* of academic and everyday knowledge and the ideological intention for critical citizenship. These curriculum contradictions and the privileging of overly mathematised problems and ways of working facilitated a number of criticisms of the NCS ML curriculum and its enactments. Julie (2006) argued that a weak and largely futuristic action component in the curriculum would negate opportunities for learners to challenge issues of domination and discrimination in their current lives. This, in turn, would risk enactments of the curriculum degenerating into nothing more than 21st century arithmetic (which, as described above, is precisely how aspects of the curriculum came to be enacted in the national examinations). Christiansen (2007) similarly questioned the potential of the subject to facilitate a 'livelihood gaze' over a 'mathematical gaze' and, so, to challenge social inequality. Two components underpinned this view: first, the organisation of the curriculum around mathematics often not useful for everyday practices; second, invocation of overly simplistic contexts lacking insight into complex phenomena. At a classroom level, inconsistent messaging in curriculum-related documents about the interplay of mathematics and contexts (Mthethwa, 2009) influenced four distinctive and sometimes incompatible pedagogic agendas in teaching and assessment practices. These agendas were: prioritisation of sense-making of contexts relevant to learners' lives, exclusive prioritisation of mathematical learning, equal consideration given to mathematical learning and relevant contexts, and prioritisation of mathematics but embedded in largely pseudo-contexts designed to foreground mathematical ideas (Venkatakrishnan & Graven, 2007). At an assessment level, North and Christiansen (2015) argued that statutory assessment practices in the subject were dominated by engagement with highly mathematised and mythologised representations of reality (the fourth pedagogic agenda above), and that this negated any opportunities for either successful apprenticeship in mathematics beyond basic competence or for more enhanced preparation for real-world functioning. By implication, participation in the subject limited rather than afforded access to future career and study opportunities and, in doing so, facilitated a degree of educational disadvantage and inequality within the institutionalised curriculum framework (North, 2015).

Second curriculum instantiation: Mathematical Literacy Curriculum and Assessment Policy Statement

In 2009, a curriculum review for all subjects was initiated by the DoE to 'address the complexities and confusion created by the NCS curriculum and assessment policy vagueness and lack of specification, document proliferation and misinterpretation' (DoE, 2009, p. 8). This review resulted in the development of CAPS for all secondary school subjects, and in the second instantiation of the curriculum for the subject ML. A key requirement of the CAPS development process was to unpack the more vaguely constituted outcomes-based statements in the NCS curricula to provide more detailed specifications of content, progression, sequencing and assessment criteria. In other words, significantly *heightened state control and regulation (framing)* of legitimate knowledge for each subject and also explicit clarification of the *recognition and realisation rules* needed for acquisition of legitimate knowledge, practice and communication. This would position the CAPS documents as the definitive source of information (DoE, 2009, p. 8) for teachers (in the *field of reproduction*) and other role players (in the *pedagogic recontextualising field*), thereby strengthening implementation by ensuring more consistency in teaching and assessment structures between the intended and enacted curriculums. This approach also constituted a move away from an outcomes-based approach in favour of a discipline-based curriculum (Graven et al., 2022) with more clearly defined and more *strongly classified subject boundaries*. Consequently, the CAPS curriculum, compared with the NCS curriculum, embodies a shift within the official recontextualisation field at curriculum level: from macro-level focused mainly around broad assessment outcomes (system and national specifications) to meso-level (school) and micro-level (classroom and teacher) with a high degree of specification and regulation of the criteria for instruction and associated pedagogic practices.

The development of the CAPS ML curriculum sought both to operationalise these ideals, and to address the previously discussed criticisms and challenges experienced in the subject as a result of the *weaker framing and classification* of knowledge of the NCS ML. In particular, a key aim was to more strongly *classify* ML as a distinct subject, with clearly identifiable *recognition* and *realisation* rules that were easily distinguishable from the evaluation criteria in Mathematics. This involved reframing the underlying ideological orientation of what constitutes mathematical literacy in the curriculum. An essential starting point here was acknowledgement that it is problematic when claims are made that heavily mathematised practices in pseudo-real contexts better prepare participants for more effective participation in real-world practices. Instead, since the mathematised world represents a mythologised version of reality (Dowling, 1998), participation with this world does not equate to more empowered functioning in the real world. To overcome this issue, the CAPS ML recontextualised (from the *field of production of mathematics education*) a particular notion of mathematical-literacy-for-empowered-life-preparation (Venkat, 2010) to foreground a primary ideological orientation for the subject as an 'empowered life-preparedness orientation'. In this orientation, the goal for the realisation of mathematical literacy is enhanced and empowered functioning and self-management in daily life and workplace practices facilitated through the capacity to use mathematics and other tools to support authentic contextual problem-solving and critical decision-making experiences (DBE, 2011a, p. 9). An empowered life-preparedness orientation affords preparation for effective functioning in everyday life through exposure to existing everyday forms of knowledge, participation and communication, and to possible alternative forms derived through mathematically and technologically informed considerations and descriptions. The orientation seeks to understand how people think, act, behave and communicate in real-world contexts, and then to explore how they might think, act, behave and communicate differently from a mathematically and technologically oriented perspective. This orientation foregrounds more contextually focused agendas for critical engagement with complex problem-solving experiences in society and the workplace (agenda 3) (Jablonka, 2003; North, 2015) and is to be achieved, pedagogically, via a particular view of the interplay of mathematical and contextual elements:

> If Mathematical Literacy is seen in this way, then a *primary* aim in this subject is to equip learners with a set of skills that transcends both the mathematical content used in solving problems and the context in which the problem is situated. In other words, both the mathematical content and the context are simply tools: the mathematical content provides learners with a means through which to explore contexts; and the contexts add meaning to the mathematical content. But what is more important is that learners develop the ability to devise and apply both mathematical and non-mathematical techniques and considerations in order to explore and make sense of any context, whether the context is familiar or not. (DBE, 2011a, p. 9: original emphasis)

The life-preparedness orientation for empowered self-management and citizenship is embodied in a number of curriculum features. These features are motivated by an attempt to strengthen the *classification* of ML as a distinctive pedagogic discourse and weaken the *classification* between academic and everyday knowledge. The features also redefine the *evaluative* (*recognition and realisation*) *rules* for legitimate communication, knowledge and practice according to engagement in authentic contextual problem-solving and informed decision-making experiences. Some of these features are captured explicitly in the descriptors of the 'five key elements of Mathematical Literacy' in the CAPS ML curriculum (DBE, 2011a, pp. 8–10). Namely, that ML involves: the use of elementary mathematical content, authentic real-life contexts, solving familiar and unfamiliar problems, decision-making and communication, and the use of integrated content and skills in solving problems. Additional features are reflected in how the curriculum and specifications of content are organised and structured, and criteria for progression. All features are based on a theoretical language of description (North, 2015, 2017) of the enabling criteria for a contextually focused agenda for critical engagement with real-world practices, and of the components deemed necessary to facilitate and operationalise this orientation in produced texts (such as textbooks, curricula and assessments). This language of description aligns with modelling approaches informed by a more a situated orientation (Niss et al., 2007, p. 5), which acknowledge heightened emphasis on the extra-mathematical realm and on developing skills that facilitate the use of mathematical and real-world knowledge in the modelling of real-world problems. These features will now be discussed and exemplified in relation to the CAPS ML curriculum extract shown in Figure 4. The discussion of these features, in conjunction with the characterisation of an empowered life-preparedness orientation in the preceding discussion, directly addresses the third research question: *In what ways and how does the intended curriculum of the CAPS ML curriculum facilitate a life-preparedness orientation for empowered self-management and citizenship?*

Feature 1: Curriculum organisation around applications

This first feature operates at the level of curriculum organisation. To foreground the importance of the real-world and applications in that world, the CAPS ML curriculum makes a distinction between 'Application Topics' and 'Basic Skills Topics' (see Figure 5). Application Topics specify the real-world contexts to be investigated and the content and skills to be applied in solving problems in those contexts. By contrast, the Basic Skills Topics (discussed in more detail in Feature 4) specify elementary mathematical content and skills that learners have been exposed to in previous grades

Topic: Maps, plans and other representations of the physical world — **Grades 10, 11 and 12**

Section	Content/skills to be developed in appropriate contexts	Grade
Plans (floor, elevation and design plans)	*Use the following plans:* • Rough and scaled floor/layout plans showing a top view perspective (Grade 10) • Rough and scaled elevation plans (front, back and side) showing a side view perspective (Grades 11 and 12) • Rough and scaled design drawings of items to be manufactured (e.g. *clothing, furniture*) (Grades 11 and 12) *In the context of:* • a familiar structure (e.g. *classroom; room in a house → bedroom or lounge*) (Grade 10) • a less familiar structure (e.g. *office space containing cubicles; a garden/tool shed*) (Grade 11) • a complex structure (e.g. *house → RDP house*) (Grade 12) *In order to:*	
	Understand the symbols and notation used on plans (e.g. *the symbol for a window is a double line; the symbol for a door is a vertical line attached to a quarter circle indicating the swing direction of the door*). Describe what is being represented on the plans. Analyse the layout of the structure shown on the plan and suggest alternative layout options. Determine actual lengths of objects shown on plans using measurement and a given scale (number or bar scale). Determine quantities of materials needed by using the plans and perimeter, area and volume calculations.	10, 11 and 12
	Understand the terms • "North Elevation"; "South Elevation"; "East Elevation"; "West Elevation" and the relevance of compass directions in the construction of buildings. Connect the features shown on elevation plans with features and perspectives shown on a floor plan of the same structure.	11 and 12
	Determine the most appropriate scale (Grade 12) in which to draw a plan and use the scale (Grade 10 and 11). *In order to:* Determine how long/wide/high an object should be drawn on a plan when actual dimensions are known. Draw scaled 2D floor and elevation plans for: • A familiar structure (e.g. *classroom; room in a house → bedroom or lounge*) (Grade 10) • A less familiar structure (e.g. *office space containing cubicles; a garden/tool shed*) (Grade 11) • A complex structure (e.g. *house → RDP house*) (Grade 12).	10, 11 and 12
	Additional comments: Additional contexts and/or resources include any other plans in the context of the learner's daily life and in less familiar contexts relating to simple and complex structures.	
	A — **Possible assessment (incorporating plans, conversions, area, surface area, finance):** Assignment: *Painting a classroom* • Create accurate 2-dimensional scaled drawings of the inside walls of a classroom • Use the plans to determine the quantity of paint needed to paint the classroom • Prepare a budget to show the projected cost of painting the classroom.	11
	Possible assessment (incorporating finance, models, plans, perimeter, area, volume): Assignment: *Building a house* • Investigate the considerations involved in the construction of a house • After interpreting the plans of a house, build a scale model and perform perimeter, area and volume calculations in the context of fencing, paint, concrete, etc. • Analyse a budget for the building project • Analyse inflation figures to predict possible adjustments to building costs.	12

Source: Department of Basic Education (DBE). (2011a). *Curriculum and Assessment Policy Statement (CAPS): Mathematical literacy* (p. 77). Pretoria: Government Printers

FIGURE 4: CAPS ML curriculum extract.

CAPS Mathematics	NCS ML curriculum	CAPS ML curriculum	
		Basic skills topics	Application topics
		Interpreting and communicating answers and calculations	
Finance, growth and decay	Numbers and operations applied in context		Finance
Number patterns, sequences and series		Number and calculations with numbers	
Functions	Functional relationships	Patterns, relationships and representations	
Analytical geometry	Shape, space and measurement		Measurement
Euclidean geometry and measurement			
Trigonometry			Maps-plans-and-other-representations-of-the-physical-world
Statistics	Data handling		Data handling
Probability			Probability
Algebra			
Differential calculus			

FIGURE 5: Organisation of the CAPS ML, NCS ML and CAPS Mathematics curricula.

and which are deemed necessary for engaging with the contents of the Applications Topics (DBE, 2011a, p. 13). These basic skills comprise, primarily, the types of numeracy skills and arithmetic fluency that a person might encounter as they go about their everyday lives. Importantly, it is the content of the Application Topics that are the main focus of learning in the CAPS ML curriculum and the Basic Skills are intended to support specified problem-solving activities in the Application Topics. Hence, no weighting is allocated to the Basic Skills contents in any assessments (DBE, 2011a, p. 8).

This separation of real-world applications and basic mathematical skills, and the foregrounding of the former in learning processes, signal that the *realisation* and *recognition rules* for the pedagogic discourse of Mathematical Literacy in the CAPS ML curriculum reside in contextual problem-solving practices rather than in the type of heavily mathematised mathematical competency practices that came to characterise enactments of the NCS curriculum.

The characterisation of the Application Topics also included an attempt to reorganise the CAPS ML curriculum differently from the mathematical content domains that structured the NCS ML. As such, the CAPS ML organises the curriculum around phenomenological categories that encapsulate broad areas of real-world experiences encountered by a self-managing individual – for example, 'Finance' and 'Maps, plans and other representations of the physical world'. This use of phenomenological categories was intended to weaken the strength of the boundary between academic and everyday knowledge (*classification*) and, so, to strengthen the classification of CAPS ML as distinctive from the structure and organisation of Mathematics. This approach contrasts with other prevalent school-level instantiations of mathematical literacy in the literature (e.g. OECD, 2018) that tend to retain more traditional content strand groupings while prioritising mathematical learning. However, the content domains of the CAPS ML curriculum remain too similar to the NCS ML curriculum and to some domains in the Mathematics curriculum (e.g. Finance and Probability). As such, it is unlikely that this attempted use of phenomenological categories will have strengthened the classification of CAPS ML from both NCS ML and Mathematics in the way intended. If a life-preparedness orientation is to be foregrounded in any future ML curriculum revisions, it is important for curriculum developers to consider whether some of the Application Topics (e.g. Probability) could be reframed even further to more closely reflect the realities of how these concepts are experienced in daily life (e.g. 'Chance and Prediction').

The curriculum extract shown in Figure 4 is from the *Maps-plans-and-other-representations-of-the-physical-world* Application Topic and specifies some of the contents, skills and problem-solving experiences expected of learners when working with design drawings and floor and elevation plans (DBE, 2011a, pp. 77–78). In addition to this curriculum topic being more directly framed around a specific area of potential real-world experience, there is a prevalence of contextual language (e.g. quantities of materials, painting a classroom) and terminology (e.g. floor plan, North Elevation; budget), reflecting more closely how people might talk about these contents in these real-life settings (i.e. *weak grammars*). Here, being mathematically literate is *recognised* as and to be *realised* by engaging in an informed way in contextual problem-solving and decision-making practices, such as 'painting a classroom', rather than according to the degree of competence with mathematical ways of working. Since exposure to these problems in the subject may support learners to successfully engage with these concepts and tasks in current and future real-life situations beyond school, herein lies the potential for empowered life-preparation and self-management.

Feature 2: Engagement with real-life contexts and problems with a high degree of authenticity and which bear a strong resemblance to reality

> In exploring and solving real-world problems, it is essential that the contexts learners are exposed to in this subject are authentic (i.e. are drawn from genuine and realistic situations) and relevant, and relate to daily life, the workplace and the wider social, political and global environments. Wherever possible, learners must be able to work with actual real-life problems and resources, rather than with problems developed around constructed, semi-real, contrived and/ or fictitious scenarios. (DBE, 2011a, p. 8)

When foregrounding an empowered life-preparedness orientation, the contexts engaged with are expected to bear a high degree of fidelity to authentic real-world practice (in ways recognised as genuine by people who work in those practices) (ML Key Element 2). However, there also needs to be recognition that any analysis of a context in a classroom setting involves a recontextualisation of the context from the terrain of the everyday world and, as such, provides a limited and situated view of a contextual environment or practice. Authentic contexts require authentic activities and authentic cultural artefacts (e.g. newspaper articles, adverts, financial documents) drawn directly from real-world fields of practice. Engagement with these contexts, activities and artefacts should aim to facilitate a greater understanding of problems encountered in those contexts. In addition, there should be recognition and valuing of multiple solution paths and real-world forms of practice and communication (see Feature 3). As such, within an empowered life-preparedness orientation, legitimate communication, knowledge and practice is *recognised* and *realised* (*evaluation rules*) through successful engagement in problem-solving and decision-making activities in segments of real-life contexts that bear a high degree of resemblance to reality, but which have been selected and potentially modified for exploration in a classroom setting. The curriculum extract shown in Figure 4 gives examples of the types of familiar (classroom; bedroom), less familiar (office) and increasingly complex (house) contexts for exploration in this topic. A defining characteristic of these and all other contexts specified in the curriculum is the clear and strong link to authentic real-life settings familiar to the learners or with the potential to be encountered in the future.

This insistence on engagement with cultural artefacts drawn from authentic real-life contexts and a valuing of real-world forms of knowledge, practice and communication (*weak grammars*) significantly weakens the boundary strength (*classification*) between academic and everyday knowledge – much more so than in the NCS ML curriculum instantiation. This further strengthens the *classification* between ML and Mathematics as distinctive school subjects characterised by distinctive *pedagogic discourses* and *evaluation criteria*. In addition, there is a deliberate specification of a larger range of exemplar contexts in the CAPS ML curriculum and these exemplars foreground more explicitly the 'authenticity' criteria of the types of contexts deemed appropriate for investigation. This heightened specification of contexts signifies strengthened state regulation of what is considered to be legitimate knowledge, while at the same time giving both teachers and learners less control and agency over the content to be taught and learned – in other words, *strengthened framing* of state control of the selection of knowledge.

Feature 3: Active problem-solving in authentic contexts

According to the CAPS ML curriculum, 'learners who are mathematically literate should have the capacity and confidence to interpret any real-life context that they encounter, and be able to identify and perform the techniques, calculations and/or other considerations needed to make sense of the context' (DBE, 2003a, p. 9). Thus, the CAPS ML curriculum explicitly prioritises engagement with genuine problems in authentic contexts to facilitate the development of problem-solving skills that lead to the potential for more informed, empowered and enhanced decision-making in those (and other) contexts (DBE, 2011a, p. 9) (ML Key Element 3). For example, as exemplified in the curriculum extract in Figure 4, 'Determine quantities of materials needed by using the plans and perimeter, area and volume calculations'. As part of their problem-solving activities, learners are expected to consider a variety of tools and content, including contextual, mathematical and technological information, meanings, methods and terminology. By using these tools, learners are expected to develop the skills to model possible solutions to problems and to consider possible alternative ways of working in contextual practices to inform informed and empowered decision-making (DBE, 2011a, pp. 8–9). Learners are also expected to recognise the necessity for reasoning and reflection on the relevance and validity of both contextual and mathematical elements. For example, in the curriculum extract in Figure 4, it is expected that learners will learn to draw and use plans and models showing objects from different perspectives to inform decisions about material quantities when completing real-world projects (such as painting a room or building a structure); they will also be helped to recognise that although the calculated solution provides an important guideline of quantities, it is common and sensible practice to buy more than the calculated quantity to account for wastage and other practical considerations (e.g. DBE, 2011a, pp. 34 & 62).

In addition, the CAPS ML also recognises and values the role of real-world forms of knowledge, communication, and flexible and less formal calculation strategies (e.g. estimation) to support problem-solving and decision-making activities (DBE, 2011a, pp. 8–9). Awareness of context-specific knowledge and terminology (e.g. Figure 4 – 'Understand the symbols and notation used on plans'), emphasis on effort-saving techniques (e.g. Figure 4 – 'Use rough plans'), and informal or less formal mathematical techniques are all valued. An example of an informal technique from the Measurement curriculum topic is: 'Determine length and/or distance using appropriate measuring instruments, including: "rule of thumb" methods (e.g. … one metre is approximately one large step/jump)' (DBE, 2011a, p. 64). Appropriate and effective communication are further essential components of the contextual problem-solving process, evidenced by the ability to make comparisons, make appropriate choices and communicate findings using terminology and tools most appropriate to the context (DBE, 2011a, pp. 9–10) (ML Key Element 4). For example, in Figure 4, 'Analyse the layout of the structure shown on the plan and suggest alternative layout options'. All of the above signal weakened *classification* between academic and everyday forms of discourse and knowledge. In addition, the valuing of contextual language, terminology and forms of communication signals a prioritisation of *weaker grammars* which may be more closely tied to specific contextual problems and situations, alongside stronger mathematical ones that can be applied across a range of contexts and problems.

In respect of the previously mentioned, being mathematically literate is *recognised* in the CAPS ML curriculum as the capacity to draw on a range of mathematical, contextual and technological tools to support problem-solving and decision-making in authentic real-world problem scenarios, and is *realised* by learners developing competence and confidence in being able to do this in relation to any contexts (familiar or not) that they encounter. Herein lies a key catalyst for potential empowerment for enhanced life-preparedness as a self-managing citizen in a way that could not be facilitated through the mathematised enactments of the original NCS ML curriculum. Note that despite the lowered teacher agency over selection, sequencing and pacing due to the strong regulation (*framing*) of the CAPS ML curriculum content, this emphasis on the development of problem-solving skills foregrounds the importance of learners as active role players in the learning process, which reinforces the empowerment agenda.

Feature 4: Competence with elementary mathematical contents and skills

Contextual problem-solving and decision-making practices require a degree of fluency with financial, numeric, spatial and statistical components of the everyday world (ML Key Element 1). This is akin to what Skovsmose (1994, p. 47) refers to as 'mathematical knowing'. As such, and as discussed previously, encapsulated primarily within Basic Skills curriculum topics is selected mathematical content drawn from mathematics curriculum specifications from earlier grades that reflects the types of numeracy and arithmetic fluency that a person might encounter in their daily lives. The CAPS ML curriculum expectation is that teachers should revise this content with learners as and when it is encountered and needed to support contextual problem-solving and decision-making activities in relation to the Application Topics (DBE, 2011a, p. 13). In addition, there is an explicit stipulation that mathematical content should not be taught in isolation of contexts (DBE, 2011a, p. 8) and that if 'calculations cannot be performed using a basic four-function calculator, then the calculation is in all likelihood not appropriate for Mathematical Literacy' (DBE, 2011a, p. 8). *Recognition* and *realisation* of the pedagogic discourse of ML, then, rest not in being able to demonstrate competency with basic mathematical skills. Instead, they are evidenced in the capacity to use some mathematics to engage meaningfully in complex problem-solving and decision-making practices in authentic real-world contexts.

The curriculum extract in Figure 4 specifies a range of mathematical content and skills embedded within the described contextual applications. For example, measurement of lengths, conversions, ratio (when using scales), analysing 2D and 3D perspectives, perimeter-area-volume calculations, cost calculations involving cost rates, percentages (inflation), and so on. Note that these mathematical concepts are always kept in service to contextual problem-solving and decision-making practices, as evidenced in the focus of the two suggested assessment activities ('painting a classroom ' and 'building a house').

As shown in the curriculum extract in Figure 4, insistence on engagement with authentic real-life contexts (Feature 2), prioritisation of problem-solving activities (Feature 3), and recognition of the importance of some mathematical content (Feature 4) are reinforced in the CAPS curriculum via highly specified statements for each learning focus. These statements utilise a sequence of sentence starters to outline the scope of the contents, contexts and problems to be explored:

> 'Use the following' (or 'Determine' or 'Measure' or ' Calculate' or 'Work with') [Content]
>
> 'In the context of [Context]
>
> 'In order to' [Problem-solving, applications and decision-making]

This structure foregrounds the importance of problem-solving as a key behaviour and skill of an empowered self-managing mathematically literate citizen. Note that 'Content' does not only imply or specify mathematical content but is also taken to signify contextually specific knowledge, strategies, language and terminology. This approach, together with the inclusion of a suggested work schedule (including time allocations) for the teaching of the curriculum content (DBE, 2011a, pp. 15–19), facilitated a more strongly *framed* and regulated specification of the selection, sequencing and pacing of curriculum content. This strengthened *framing* enabled a more explicit statement of the *recognition* and *realisation rules* for what it means to be mathematically literate around contextual problem-solving and decision-making practices than was evident in the NCS curriculum, thereby strengthening the *classification* of the pedagogic discourse of ML as distinctive from Mathematics. Strengthened framing of the curriculum in this way was intended to ensure greater consistency between the intended curriculum and assessments produced in the *official recontextualising field*, textbooks produced in the *pedagogic recontextualising field*, and teachers' pedagogic practices in the *field of reproduction*. Doing this, however, significantly weakened teacher agency over both content and pedagogy (in the *field of reproduction*). In addition, the CAPS ML instantiation does not provide an explicit explanation of the significance of these sentence starters for outlining the interplay of the content, contexts and problems to be explored. This is another oversight in the curriculum design that may have affected curriculum users' understanding of the specific interplay of mathematics and contexts envisioned for supporting an empowered life-preparedness orientation for contextual problem-solving and decision-making.

Feature 5: Integration of contents and skills across topics

Problems encountered in everyday and workplace contexts rarely involve only a single piece of knowledge, content or skill and, rather, more commonly involve the use of several of these drawn from a range of topics and sources (Tout et al., 2021). To reflect the intricate and intertwined nature of real-life problem-solving experiences, a deliberate attempt is made in the CAPS ML instantiation to signal cross-referenced links between different curriculum topics to encourage curriculum users to consider the holistic nature of contextual problem-solving practices (DBE, 2011a, p. 10) (ML Key Element 5). In other words, to support an empowered life-preparedness orientation, an attempt is made to weaken the *classification* between topic areas within the curriculum. For example, as shown in the curriculum extract in Figure 4, cross-referenced links are made to budgets and inflation (Finance), and to perimeter-area-volume calculations, measurement of lengths and compass directions (Measurement), since these are common topics that people encounter when working with plans in real-life settings.

Feature 6: Curriculum progression linked to complexity of contexts, content and problem-solving experiences

According to the CAPS ML curriculum, progression refers to the 'process of developing more advanced and complex knowledge and skills' (DBE, 2011a, p. 11). In many mathematics subjects, progression is defined principally according to engagement with increasingly complex and abstract mathematical contents. Shifting the *recognition* and *realisation rules* in the CAPS ML to an empowered life-preparedness orientation necessitated a change in the way in which knowledge development was conceptualised and sequenced in the learning process. As such, progression in the CAPS ML curriculum occurs in relation to three interlinked dimensions: familiarity and complexity of contexts, complexity of content (mathematical and contextual knowledge, tools, resources, language and terminology), and increased independence in managing problem-solving experiences (DBE, 2011a, pp. 11–12).

In terms of familiarity and complexity of contexts, 'Moving from Grade 10 to Grade 12, the contexts become less familiar and more removed from the experience of the learner and, hence, less accessible and more demanding' (DBE, 2011a, p. 12). However, it is impossible to separate out the interplay between the contexts explored and the content engaged with in those contexts. Thus, progression is seen to occur in relation to the familiarity of a context and/or the complexity of the content being engaged with in a context. The 'and/or' is deliberate: it signals that at times the widening scope and unfamiliarity of contexts may embody more complex issues and real-life artefacts. At other times, however, the scope and familiarity of the contexts may remain unchanged, with the indicator of progression linked instead to the complexity of the resources and tasks to be engaged in the contexts.

So, in Grade 10, specific 'content' is explored in *contexts* that are linked primarily to the learners' daily lives and school environment. For example, 'plans' of a *classroom* or room in a *house* (Figure 4), [Finance] *household* 'budgets'; [Measurement] 'measuring weights' for *home cooking situations*, [Data Handling] 'analysing data' on a *personal cell-phone bill*. In Grade 11 the scope of contexts is expanded to include scenarios in the wider community and workplace environment – thus, potentially further removed from the learners' immediate experiences and understanding. For example, 'plans' of an *office space* (Figure 4), 'payslips' for a *job*, using 'electronic measures to measure weights' accurately in a *workplace* context, 'analysing data' for a *small business*). And, in Grade 12, the scope of contexts now includes issues on a national and global scale and more complex projects. For example, 'plans' for a *house* (Figure 4), the impact of 'inflation' on *household* 'disposable income', analysing 'weight growth charts' given to *new parents*, analysing 'national' *health* 'data'. Note that in these Grade 12 examples, for house plans (in Figure 4) and inflation it is the complexity of the 'content' (plans and inflation) rather than the (un)familiarity of the contexts that signals the indicator of progression, since both examples refer to household contexts that could be classified as a 'familiar'.

In terms of problem-solving experiences, increasing the complexity of contexts and content necessitates that learners engage in and with more complicated problems involving more complex and larger data and information. There is also the expectation that by the end of the qualification (Grade 12) learners can independently identify and use appropriate tools to model solutions and solve problems (DBE, 2011a, p. 12), which the CAPS ML curriculum posits as a key characteristic of a mathematically literate person (DBE, 2011a, p. 12). In Grades 10 and 11, by contrast, these problem-solving experiences involve higher levels of scaffolding and guidance (DBE, 2011a, p. 12). In relation to the curriculum extract in Figure 4, as the content and/or contexts become more complex (moving from a floorplan of a room to a floorplan of a house), so too does the complexity of the problem-solving required to successfully complete tasks in those contexts. For example, in Grade 10 learners are given scaled plans of familiar or smaller structures to interpret and work with or are given the scales in which to draw plans of these structures. In Grade 12, by contrast, learners have to first determine appropriate scales and then draw plans of more complex and potentially larger structures.

Implications, challenges and conclusion

Is curriculum design for empowered life-preparedness and enhanced self-management really possible?

The CAPS curriculum makes a deliberate attempt to more strongly classify CAPS ML from Mathematics and to reformulate the recognition and realisation rules for the subject around the knowledge, skills and practices needed to facilitate empowered life-preparedness. However, there is some evidence that current enactments of this CAPS curriculum in national assessments and localised teaching experiences deviate from the orientation for empowered life-preparedness in the intended curriculum. North (2017) highlights how questions in national assessments continue to prioritise heavily mathematised ways of working in overly simplified pseudo-real contexts. Graven et al. (2022), also focusing on enactments of the curriculum in national assessments, similarly signal the continued prioritising of mathematised ways of working. They go further to problematise the type of reasoning and reflection legitimised in the examinations, arguing that the limited expectations for more open-ended reasoning and reflection thwart any opportunities for the types of discussions and thinking that would facilitate critical citizenship. At a classroom level, Khoza (2015) highlights the lack of awareness among teachers across a range of subjects (including ML) of the ideological and theoretical underpinnings of the current curriculum documents. As a result, these teachers continue to teach in traditional ways based on their past teaching experiences rather than trying to teach with fidelity to the ideology of the intended curriculum for their respective subjects. For the ML teachers in Khoza's study, this involved continuing to foreground and prioritise mathematical knowledge, skills and ways of working. However, Machaba (2017) identifies that ML teachers do see ML and Mathematics as different and distinguish the types of teaching approaches in each subject: CAPS ML involves problem-solving and reasoning, while CAPS Mathematics involves rules, procedures, direct teaching and lots of practice. Despite teachers making this distinction, the examples that the teachers in Machaba's study refer to in explaining differences reflect heavily mathematised problems.

Only tentative suggestions can be offered for the persistence of these deviations towards mathematically oriented ways of working, as this remains an under-researched area. One reason could be the challenges that teachers face with their own contextual knowledge of complex real-life experiences, and of appropriate pedagogical strategies for teaching this contextual knowledge (Pillay & Bansilal, 2019). In addition, since many ML teachers have qualifications and backgrounds in teaching mathematics and limited training in how to teach ML (Machaba, 2017, p. 95), there may be a natural tendency for these teachers to prioritise more familiar mathematical ways of working over less familiar contextual elements. Linked to this is the prevailing issue of context relevance: given the significant socio-economic disparities between different groups in South Africa, examiners in particular need to ensure that the contexts in the national assessments don't adversely benefit or disadvantage different groups. Shifting focus to mathematical content and downplaying contextual elements alleviates this issue to some extent. A further reason could be the difficulties faced by many learners with the heightened reading, interpretation and comprehension demands ushered in by the inclusion of contextual elements, particularly since the overwhelming majority of the learners in this subject do not have English as their home language. This was an issue that Debba (2011) identified in respect of enactments of the NCS ML curriculum, and it is likely that this remains an issue with the CAPS ML curriculum given the heightened expectations for engagement with authentic contexts and context-specific language, content and methods.

All of these issues warrant further investigation and point to the complexity of foregrounding an interplay of mathematics and context that places heightened emphasis on authentic contextual problem-solving and decision-making practices. Additional research is needed to better understand deviations from the intended curriculum (e.g. in the national examinations). This will enable analysis of how these deviations affect the way in which the curriculum is recontextualised (e.g. in textbooks in the pedagogic recontextualising field) and reproduced in pedagogic interactions (in the field of reproduction). This, in turn, will facilitate evaluation of the implications of these enactments for whether and how the empowered citizenship agenda is enacted. Empirical evidence is also needed to evaluate whether and how the life-preparedness orientation of the CAPS ML, and the curriculum features that support this agenda, facilitate empowerment in the way that is conceptualised in the curriculum. Finally, additional research is needed into the impact of the learners' poor prior mathematical understandings from the General Education and Training band on their capacity for complex contextual problem-solving and decision-making.

As valid as these issues are, prioritising heavily mathematised ways of working over contextual problem-solving and decision-making practices runs the risk of undermining any agenda for empowerment by repositioning Mathematical Literacy in a mathematical frame and reconstituting it as a lesser form of mathematics. Empowerment for the 21st century future depends on flexible use of a range of tools and content drawn from a range of sources to solve complex problems in a variety of contexts. This can only be achieved if we acknowledge the limitations of mathematics for making sense of the world and focus attention instead on giving learners learning experiences that will actually enable them to become more independent, empowered and critical self-managing citizens. This perspective has clear implications for all involved in any future ML curriculum revision initiatives and associated teaching, learning, assessment, teacher training and professional development resources for the subject. Taking seriously the life-preparedness orientation of the curriculum and an agenda for empowerment requires careful attention to the interplay between contextual, mathematical and technological knowledge and, particularly, to the way in which opportunities for problem-solving in authentic real-life contexts are foregrounded and prioritised over mathematical ways of working. Anything less runs the risk of subjugating the hundreds-of-thousands of learners enrolled in ML to a limiting educational experience.

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M.P.N. declares that they are the sole author of this article and took full responsibility for all aspects involved in the conceptualisation, authoring, editing and submission of the article.

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